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ADDITIONS TO THE ECHIUROID FAUNA OF THE NORTH PACIFIC OCEAN

By Walter Kenrick Fisher

The material upon which this paper is based consists of a specimen donated by Dr. J. E. Lynch, of the University of Washington, and others dredged off the coast of California by the steamer *Albatross* in 1904. The *Albatross* specimens are a part of a considerable collection of unworked sipunculoid and echiuroid worms, accumulated by the late Prof. H. B. Ward, which did not become available for study until after the publication of my "Echiuroid Worms of the North Pacific Ocean" (1946). About a third of this collection, including some of the echiuroids of California, had deteriorated beyond redemption. What remains is of considerable interest. There is a new and primitive genus of the Bonelliidae, while *Arhynchite*, supposed to lack a proboscis, can now be shown to possess a well-developed one.

I have used this opportunity to revise the keys to the genera of the families Echiuridae and Bonelliidae.

SYNOPSIS OF GENERA OF ECHIURIDAE

a [1]. Two circles of caudal setae ..... Echiurus Guérin-Méneville, 1831
a [2]. No posterior setae present.
  b [1]. No differentiated thicker bands in longitudinal muscle layer.
    c [1]. Nephrostome of nephridia without elongated spirally coiled lips.
      d [1]. Neurointestinal blood vessel in direct connection with dorsal vessel by a ring vessel at end of foregut; segment of intestine between ring vessel and beginning of siphon short and with ciliated groove; nephrostome with inconspicuous lips; proboscis not especially expanded at tip, often deciduous ..... Thalassema Lamarck, 1801

*d*². Neurointestinal vessel connected with dorsal vessel directly by a ring vessel or indirectly by numerous capillaries in wall of gut; segment of intestine between stomach and beginning of siphon very long (2 or 3 times body length), with or without ciliated groove; nephrostome with conspicuous flaplike lip; proboscis very deciduous, long, slender, expanded at tip..... **Arhynchite** Sato, 1937

*c*². Nephrostome with elongated, usually spirally coiled lips. **Anelassorhynchus** Annandale, 1922

*b*². Longitudinal muscle layer with very slight to pronounced differentiation into longitudinal bands, 6 or more in number.

*c*¹. Nephrostome of nephridia without spirally coiled lips; inner layer of muscles not differentiated into separate transverse fascicles between longitudinal bands..... **Lissomyema** Fisher, 1946

*c*². Nephrostome with elongated spirally coiled lips.

*d*¹. Differentiated longitudinal muscle bands weak, zones between not showing a fasciculate arrangement of inner oblique muscles; in small specimens longitudinal bands very faint or visible only in posterior region..... **Listriolobus** W. Fischer, 1926

*d*². Longitudinal muscle bands strongly developed, the zones between crossed by separated fascicles of innermost, oblique layer.

*e*¹. Nephridia in 1 to 5 pairs; vascular ring at beginning of midgut. **Ochetostoma** Leuckart and Rüppell, 1828

*e*². Nephridia, at least in male, in 6 to 14 groups of 1 to 4, the groups arranged in pairs; vascular ring vessel at posterior end of pharynx..... **Ikedosoma** Bock, 1942

Genus ANELASSORHYNCHUS Annandale

Anelassorhynchus ANNANDALE, 1922, p. 148 (type, *Thalassema branchiorhynchus* Annandale and Kemp, 1915).

Diagnosis.—Resembling *Thalassema* s. s. in having the longitudinal muscle layer of the body of uniform thickness without specialized longitudinal bands, but differing in having prolonged, often spirally coiled, lips to nephrostome.

Remarks.—Annandale based the genus on the structure of the proboscis of two species, *Th. branchiorhynchus* and *Th. dendrorhynchus.* In these Indian species the proboscis is short, stout, not very extensile, and the lateral margins bear dendritic gill-like outgrowths. The first species was found in a tidal creek on the outskirts of Calcutta, the latter in Chilka Lake, a lagoon on the east coast of India and connected with the Bay of Bengal. He also included *Th. sabinum* Lanchester, a brackish-water species, and *Th. microrhynchus* Prashad from Chandipore, Orissa, which do have dendritic outgrowths. In 1935 Prashad described another species having a frilly margin to the proboscis—*Thalassema marshalli* found in estuarine waters of the Irriwaddy River near Rangoon and congeneric with *Th. branchiorhynchus.*

It seems to me that the modifications of the proboscis, which exhibit a number of gradations in complexity, are adaptations to an ecology

in several ways abnormal, a parallel development being found in *Ochetostoma arkati* (Prashad). But these species agree with others having a normal proboscis in the character of the nephrostome in combination with the absence of longitudinal muscle bands.

The following species belong in this genus:

a [1]. With 1 pair of nephridia opening behind setae..... abyssalis, new species
a [2]. With 2 pairs of nephridia opening behind setae.
  b [1]. Adherent proboscis with more or less frilly margin.
    branchiorhynchus (Annandale and Kemp)
    dendrorhynchus (Annandale and Kemp)
    marshalli (Prashad)
  b [2]. Proboscis adherent but its margin not modified.. microrhynchus (Prashad)
    sabinus (Lanchester)
  b [3]. Proboscis deciduous..... semoni (Fischer)
    porcellus Fisher [1]
a [3]. With 3 pairs of nephridia.
  b [1]. All nephridia opening behind setae..... mucosus (Ikeda)
    vegrandis (Lampert)
  b [2]. First pair of nephridia opening in front of setae..... inanensis (Ikeda)
    moebii (Greef)

ANELASSORHYNCHUS ABYSSALIS, new species

PLATE 28

Diagnosis.—Differing from all known species of the genus in having only one pair of nephridia; neurointestinal vessel connected with dorsal vessel by numerous small vessels in wall of stomach; therefore no direct ring vessel present.

Description.—All specimens are in a deplorable condition, the viscera having been lost through anus, probably owing to release of water pressure. All have lost the proboscis and all except type the setae and anterior visceral complex. None has the anal vesicles. Longest specimen, probably unnaturally elongated, 230 mm.; type, 85 mm.; slender, distorted. Body wall slightly translucent, probably markedly so in life. Skin smooth, with numerous scattered papillae almost flush with surface and more translucent than the skin, so that they resemble tiny grains of cooked tapioca. In the head region of type they are convex, opaque, and more normal, but not visible without some magnification. Coelomic surface of body wall smooth, but in contracted specimen the longitudinal layer is crossed by wavy dark lines encircling body.

Setae two, close together and close to mouth. They are 10 mm. long with a relatively large, open, curved hook. The slender interbasal muscle is not surrounded by the neurointestinal vessel. The very numerous basilateral muscles are long and slender. The muscles from proximal end of sheath to lateral body wall are separated from

[1] Pacific Sci., vol. 2, p. 274, Oct. 1948.

the innermost muscle layer for most of their length and are not in the form of a dissepiment at right angles to body wall.

Nephridia two, small, the lips of nephrostome greatly prolonged but not in a spiral. Nephridiopores are rather close behind the setae, but farther from nerve cord than setae.

The foregut survived only in the type. It is fairly long, with a well-marked gizzard, the anterior end of which coincides with the posterior margin of the double ventral mesentery. In front is the esophagus, thrown into loops and held in place by the ventral mesenteries, while the short pharynx is attached to body wall by numerous radiating muscular frenula. The stomach is more inflated than gizzard, and its translucent walls are marked by longitudinal lines. A a very short distance posterior to attachment of neurointestinal vessel a very inconspicuous ciliated groove begins, but the length of presiphonal intestine can not be determined. In one specimen are two fragments of the intestine having a well-developed siphon.

The vascular system is characterized by absence of any relation with the interbasal muscle of setae, and the absence of a direct well-marked ring vessel. Near the intestine the neurointestinal vessel divides in two, and where it meets the wall at posterior end of stomach there is a slight inflation. But beyond this point there is no simple vessel passing over the wall to join the dorsal blood vessel, the inflated part of which ends at middle of stomach, to be continued a short distance by a very constricted vessel. There seems to be no alternative but a nexus through numerous small vessels in the wall of stomach, a very unusual condition outside the Bonelliidae (except in *Arhynchite*).

Type.—U.S.N.M. No. 21082.

Type locality.—*Albatross* station 4547, 10.5 miles northwest of Point Pinos, Monterey Bay, Calif., 1,083 fathoms, gray mud, rocks, June 6, 1904, 4 specimens. Near this locality, at station 4537, 1,041 fathoms, the bottom temperature was 38.5° F.

Genus LISTRIOLOBUS W. Fischer

Listriolobus W. Fischer, 1926, p. 110 (type, *Listriolobus bahamensis* Fischer).—Fisher, 1946, p. 233.

Diagnosis.—Differing from *Thalassema* s. s. in having elongate, spirally coiled lips to nephrostome and 6 to 16 (type) narrow meridional thickenings of the middle longitudinal muscle layer. Differing from *Anelassorhynchus* in having these same muscle bands, and from *Ochetostoma* in having the inner oblique layer a smooth continuous sheet not divided between the muscle bands into separate fascicles. Nephridia one to three pairs; interbasal muscle of setae present or absent.

Remarks.—The type of this genus is the species from Green Turtle Bay, off Great Abaco Island, Bahamas, which Charles B. Wilson (1900, p. 176) erroneously identified as *Ochetostoma erythrogrammon* Leuckart and Rüppell and which Wilhelm Fischer (1926, p. 110) named *Listriolobus bahamensis.* The generic name derives from Spengel (1912, p. 316), who pointed out the peculiarity of the muscle bands but neglected to designate a species with a valid name, mentioning only *Thalassema erythrogrammon* of Sluiter (1883) and of Wilson (1900), neither being true *erythrogrammon* (the type of *Ochetostoma*).

I designated *L. bahamensis* as the type (1946, p. 233). Wilson's specimen was 160 mm. long, including proboscis 30 mm., and 24 mm. in greatest diameter. Longitudinal muscle bands 16, about 1.5 mm. wide, with interspaces 4.5 to 7 mm. wide at middle of body. There were three pairs of nephridia enormously swollen and packed with sperm. The anterior pair opened 3 mm. in front of the setae and all three pairs were furnished with spirally coiled nephrostome lips. Anal glands, 90 mm. long and without visible funnels. Interbasal muscle of setae not mentioned.

I have examined a small, contracted specimen from Cayo Cristo, Cuba (American Museum of Natural History), which is probably *L. bahamensis.* It is only 20 mm. long, lacks a proboscis, and the muscle bands are not all clearly defined, but it agrees with Wilson's description in essentials. There are three pairs of nephridia, the anteriormost just in front of the setae, which are enveloped by a cone of muscle without obvious separated fascicles of muscle. There is no interbasal muscle. The foregut is close to the nerve cord so that the ventral mesentery is poorly developed. The pharynx is thin walled and esophagus long, but the gizzard and stomach can not be identified on account of poor preservation. The neurointestinal vessel is double but unites before joining ventral vessel. At the dorsal end each branch seems to join directly the dorsal vessel, a definite ring vessel not being apparent. The anal vesicles are very long and there is a coecum in front of the large cloaca.

In his revision, Bock (1942) gave *Listriolobus* at best only subgeneric rank under *Ochetostoma*, but *L. pelodes* Fisher (1946) with two pairs of nephridia and eight muscle bands was not then known. Now the discovery of a new, well-marked species with only one pair of nephridia and six muscle bands greatly strengthens the position of *Listriolobus* as a group of generic stature.

LISTRIOLOBUS HEXAMYOTUS, new species

PLATE 29

Diagnosis.—Differing from all known species in having only six longitudinal muscle bands and one pair of nephridia; neurointestinal blood vessel does not form a loop surrounding interbasal muscle, but it is undivided from ventral blood vessel to gut where there is an inconspicuous ring vessel; foregut very short; body wall translucent; proboscis unknown.

Description.—Length 40–63 mm.; thickness 7–10 mm.; proboscis lost; form subcylindrical, sometimes slightly produced at anterior end. The thoroughly relaxed type has a thin translucent body wall and the six longitudinal muscle bands are very inconspicuous. The other 3 specimens are contracted and have an opaque body wall marked by six shallow longitudinal furrows representing the muscle bands. Only under strong magnification are the papillae visible—largest at anterior end. These are low, conical, with a central dark spot, and are in spaced transverse series. They can be best seen only in the relaxed type. When the skin is contracted they may be more or less submerged in the folds, though here and there on limited areas they are definite enough. Color gray or brownish gray. Coelomic surface smooth, the inner oblique layer not interrupted, as in *Ochetostoma*, by the longitudinal bands.

Setae two, relatively long, close together, with a slender interbasal muscle which does not pass through a loop of the neurointestinal blood vessel. There are a large number of very slender and long basilateral muscles, only a few of which are indicated in the figure. The seta sheaths are connected at body wall by a strong transverse muscle; and extending laterally, at right angles to body wall like a low dissepiment, is a muscular apparatus the purpose of which apparently is to separate the distal ends of setae (pl. 29, fig. 2, *SM*).

Nephridia only two, very small, with a conspicuous nephrostome having an obvious neck and the lips produced as in other members of the genus. There are no genital products in the nephridia.

Anal vesicles relatively very small, only 8 or 9 mm. long in the type (length 63 mm.), thin walled and without special features. The cloaca is also very small (about 2 mm. long), but very muscular. The end of the nerve cord passes on to its ventral surface and divides into two trunks, which appear to end at the narrow constriction between intestine and cloaca.

The alimentary canal is of moderate length, very delicate, and the thin-walled intestine is crowded with mud pellets. The foregut is short, much shorter than in *L. pelodes* Fisher, and its parts are not readily recognizable. Both gizzard and stomach are reduced almost to a minimum (pl. 29, fig. 2). The presiphonal intestine is also of

moderate length. The whole complex in a relaxed specimen appears to be moved far forward and to be dominated by the setae and their numerous muscles. I was unable to find the coecum in the type, but in another specimen there is a very small spongy body in the proper location. In *L. pelodes* it is of normal size.

The vascular system differs from that of *L. pelodes* in respect to the neurointestinal vessel which has no loop surrounding the interbasal muscle of setae and does not divide into two until it reaches the gut, where the ring vessel is inconspicuous.

Type.—U.S.N.M. No. 21079.

Type locality.—*Albatross* station 4339, off San Diego, Calif., 287–369 fathoms, green mud, March 10, 1904; 4 specimens.

Genus ARHYNCHITE Sato

Arhynchite Sato, 1937, p. 142 (type, *Thalassema arhynchite* Ikeda).

Diagnosis.—Proboscis deciduous, long, slender, ribbonlike, with a small, expanded, fan-shaped extremity, and a closed base forming lower lip; nephridia two, the nephrostome with one lip prominently produced, leaflike and with an irregular or laciniate margin; alimentary canal very long, the presiphonal segment two to three times body length, with or without a ciliated groove; blood system with or lacking a ring vessel; no coecum; anal vesicles *Thalassema*-like; muscles of body wall smooth with no concentration of fibres into bands; setae two, with interbasal muscle.

Remarks.—The discovery of a well-developed proboscis in two species is interesting to say the least. Ikeda examined carefully a number of specimens from Sapporo and was convinced that a proboscis was not present, while Sato sectioned the mouth region. "No trace of a detached proboscis was found, and thus the mouth opening was entirely enclosed by means of the papillae which were regularly arranged around the mouth" (1937, p. 145). What Sato did not do was to trace the ventral nerve to ascertain if it formed a ring around the mouth, the only real test. I dissected one of the specimens of *californicus* and found the nerve cord to be ruptured at the point where it divides into two. But superficially there is no hint that a proboscis has been detached, and this was true also of *A. inamoenus*, which I described in 1946 (p. 247).

I think the discovery of a proboscis in the two species herein described need not invalidate the genus. The nephrostome and the very long presiphonal segment of the intestine separate the group from *Thalassema*. Also the form of the proboscis is different from that of *Thalassema*. The absence of a ring vessel in *inamoenus* and *californicus* would be a useful distinction but unfortunately *puget-*

tensis has an especially large one, while in *arhynchite* of Japan the connection between dorsal and neurointestinal vessels seems to be direct. The absence of a coecum indicates a certain remoteness from *Thalassema*.

The males do not differ from females except in the gonads.

ARHYNCHITE CALIFORNICUS, new species

PLATE 30

Diagnosis.—Differing from *A. arhynchite* of Japan (in which proboscis is unknown) in having an indirect connection between dorsal and neurointestinal blood vessels, larger anal vesicles with one or two large frenula; and possibly also in the form of the nephrostome.

Description.—Body form like a blunt cigar; length 70 to 90 mm.; diameter about 15 to 20 mm. Body wall rather thick, opaque, the skin with small, spaced, unequal, convex glands, which form more or less distinct transverse rows or interrupted rings. Between the glands are very fine transverse wrinkles. At both ends of body the glands are very much larger, often low papilliform, especially ventrally, and much more conspicuous than on middle region of body where they are sometimes nearly obliterated.

The proboscis, of which there are five detached examples having lengths of 65, 72, 82, and 85 mm., is ribbonlike, thin, and 5 mm. broad at the maximum. The somewhat fan-shaped expanded tip has a thickened border, which reappears on the proximal half of the stem, here being scalloped or fluted. The margin closes in and joins close to the base, forming the lower lip. Probably in life the margins meet, forming a tube. The nerve can be easily traced near the margin and follows closely the border of the distal fan, within the thickened portion. Also down the center the median blood vessel can be seen in the central mass of longitudinal muscle fibres. At its base the proboscis is constricted and when in place on the animal is surrounded by the ring of papillae (beneath which are strong sphincters) which have been mistaken for lips. The functional mouth is detached with the proboscis and is very small.

Setae two, close to anterior end, 6.5 mm. long, with a hook very similar to that of *inamoenus* (in which setae are 11 mm.). Interbasal muscle well developed, passing through a small loop of neurointestinal vessel.

Nephridia two, inserted not quite so close to nerve cord as in *inamoenus* and behind setae a distance about equal to length of latter. In the type there is an extra nephridium on right side, inserted in front of seta and close to it. Nephridia vary greatly in extent of

inflation. Characteristic is a flaplike nephrostome of variable but conspicuous size (upward of 4 mm. long) having a lobed or laciniate border and a crescentic slit near base on anterior or ventral side. It is much larger than in *inamoenus*, which lacks the lobes. Both specimens are males.

Anal vesicles two, thin-walled, voluminous at base and terminally slender. They are 40 to 60 mm. long and hence over half the length of body. A characteristic feature is the presence of one or two broad frenula at about two-thirds the length from base. These, and slender frenula near the base, anchor the vesicles to body wall. Ciliated cups are widely scattered on surface of vesicle. The cloaca is very small, the length sufficient only to accommodate the base of the vesicles which are attached close together on the ventral side. Mucosa of cloaca is longitudinally plicated. A slight thickening of tissue at end of ciliated groove, where the intestine joins the cloaca, may represent a vestigial coecum, but it is very small, and not comparable to the normal coecum of *Thalassema*.

Alimentary canal excessively long, with numerous coils attached to body by a multitude of rather strong frenula. In a specimen 80 mm. long, having the gut not overstuffed with pellets, the foregut is 30 mm., presiphonal intestine 200 mm., siphonal segment 160 mm., and postsiphonal, provided with ciliated groove, 235 mm.; total, 652 mm. The foregut is not clearly subdivided. Back of the pharynx-esophagus there is a region about 9 mm. long having the ring markings of the gizzard, leaving an unusually short segment for the stomach (*C*). The very long presiphonal intestine has no ciliated groove. The anterior portion of it lies near the nerve cord and proceeds to posterior end of body, where there is a sharp bend forward.

The blood system is characterized by an indirect or capillary connection between the dorsal and neurointestinal vessels, no ring vessel being present. The neurointestinal vessel forms a small loop around the interbasal muscle of setae; in *inamoenus* the loop is not present.

Type.—U.S.N.M. No. 21085.

Type locality.—*Albatross* station 4525, Monterey Bay, Calif., 9.4 miles northeast of Point Pinos, 222 fathoms, soft gray mud, May 26, 1904, 2 specimens. A third mutilated specimen and five proboscises were in container.

ARHYNCHITE PUGETTENSIS, new species

PLATES 31, 32

Diagnosis.—Differing from *A. californicus* in having a conspicuous ring blood vessel at end of foregut and a well-developed ciliated groove

throughout the length of the presiphonal segment of intestine; length 100 mm.; thickness 15–18 mm.

Description.—The body is cylindrical, abruptly tapered and blunt at both ends. The skin is covered all over with closely placed elevated irregular glands of several sizes, spaced less than the diameter of the largest. They are larger at the ends of body but are perfectly visible to the naked eye all over the surface and there is no smooth area anywhere. Between the glands the skin is finely wrinkled transversely. The glands were more prominent when the specimen was in formalin than when subsequently preserved in alcohol. Only the basal 18 mm. of the proboscis remains. The margin joins at the base as in *californicus* to form the lower lip, and the concave surface is reddish brown.

Setae two, strong, terminally evenly curved, and only about 5 mm. behind mouth. There is an interbasal muscle that passes through the neurointestinal blood vessel.

Nephridia two, longer than the preserved specimen and filled with eggs (May 22). The nephrostome has the characteristic expanded lip with a lobed or shallowly laciniate border and is about 4 mm. long, but in life is probably longer.

The anal vesicles are unequal in size; probably the inequality is abnormal. The ciliated funnels are very small and well spaced.

Alimentary canal: The plan of the alimentary canal is shown in plate 31, figure 1. The middle portion (siphonal gut) is anchored to the dorsal and dorsolateral regions of body wall, while the presiphonal gut (black) and hindgut (stippled) is fastened to the ventral and ventrolateral walls. The presiphonal gut consists of a long loop, the proximal half of which is anchored by very numerous frenula close to right side of nerve cord. But the segment between + and + is anchored by very numerous frenula to a cablelike muscle attached forward (pl. 31, fig. 2). There is a conspicuous ciliated groove extending the entire length of the presiphonal gut, the outer wall of the proximal half of which is marked by transverse folds. The siphon is well developed but is not indicated in figure. This siphonal region of intestine (unshaded in figure) lies dorsally to the rest, while the postsiphonal portion, characterized by ciliated groove, is mostly on the left side. Its distal part is attached to the left of nerve cord. The ciliated groove ends ventrally, in the usual place near end of ventral blood vessel, but there is no coecum. The cloaca is relatively small, and the outlet of each anal vesicle is close to anus. The contents of intestine are not molded into pellets.

The foregut has a constriction between the pharynx-esophagus and the gizzard-stomach. The latter is marked by longitudinal and circular lines reflecting the grooves of the lining, but there is no sharp

distinction between the gizzard and the stomach (crop), which ends at the ring blood vessel.

VASCULAR SYSTEM: The vascular system differs sharply from that of *inamoenus* and *californicus* in having a clear-cut large ring vessel. The dorsal blood vessel is voluminous; its anterior part is held in place by broad dorsal frenula which anchor the pharynx. Then follows a free portion over the posterior part of pharynx-esophagus. Posterior to this it is attached to the gizzard by a broad continuous mesentery, from the front edge of which anchoring strands proceed forward to surface of pharynx. Then posteriorly the dorsal vessel is attached to wall of stomach, spiraling to right from the dorsal to ventral side, so that the neurointestinal vessel enters the ring vessel dorsolaterally. The interbasal muscle of setae passes through a loop of the neurointestinal.

Color in formalin, lavender-gray.

Type.—U.S.N.M. No. 21098.

Type-locality.—Puget Sound, Wash. (Normandy Beach, 12 miles south of Seattle), lower limits of a minus 2-foot tide, clam grounds, May 22, 1948, 1 specimen, Sigurd J. Westrheim, collector.

Remarks.—Dr. J. E. Lynch, of the School of Fisheries, University of Washington, who contributed the type specimen, states that to the best of his knowledge this is the first adult echiuroid to be collected in Puget Sound.

The species is very distinct from *californicus* and *inamoenus* in having a direct connection between the dorsal and neurointestinal blood vessels. A careful examination of the presiphonal gut of *californicus* did not reveal any ciliated groove. The material of this species is in too poor condition to ascertain details of the intestinal fastening muscles or frenula and hence whether the arrangement for the presiphonal gut of *pugettensis* is peculiar to the species. The details of the mesentery of the dorsal blood vessel and the shorter lobes of the nephrostomes appear to be of specific value. The great size of the nephridia is probably due to their being packed with eggs, while the disparity in size of the anal vesicles may be an abnormality.

A. arhynchite (Ikeda) of Japan seems to have smaller skin glands and to lack the large ring vessel, but details of the alimentary canal are not available.

Family BONELLIIDAE Baird

In the construction of the following synopsis the first division has been made according to the position of the nephrostome, whether at base of nephridium, at its extreme tip, or placed laterally near the distal end. As the outstanding structural peculiarity common to the whole family, I think modifications of the nephridia contain the key

to major subdivisions. The form of the proboscis is perhaps equally valid, but this organ is obviously more susceptible to environmental influences and it is unfortunately sometimes missing. As a working hypothesis I have assumed that basal nephrostomes are the most primitive; that two nephridia are more ancestral than one, for the same reason that an undivided proboscis is more ancestral; and that the occurrence of two setae, with typical echiuroidean muscle apparatus, precedes in evolution a condition where there are numerous setae having a modified muscle apparatus, or none, or where the setae have disappeared altogether.

In my 1946 key I omitted *Sluiterina* Monro, 1927, and used *Parabonellia* Onoda, 1935, instead of *Ikedella* Monro. I had not then seen the figures published by Wesenberg-Lund (1934, p. 8) and Stephen (1941, pl. 8, fig. 1) clearly demonstrating that *Hamingia arctica* has a terminally bilobed proboscis, not at all thalassemoid, as Monroe, I, and others had supposed.

SYNOPSIS OF GENERA OF BONELLIIDAE

a[1]. Nephrostome situated at base of nephridium.
  b[1]. Proboscis not branched or cleft at tip; absent in *Nellobia*.
    c[1]. Two nephridia.
      d[1]. Female with 2 well-developed setae; anal vesicles wide sacs provided with a very large number of slender excretory tubules having apical funnel; dorsal vessel of vascular system in direct connection with neurointestinal; male unknown.
        e[1]. Proboscis without specialized funnel at its base; nephridia opening to exterior by separate pores; external ends of setae can retract into a common bursa ---------- **Maxmülleria Bock, 1942**
        e[2]. Proboscis with a specialized cup or funnel at its base; nephridia opening to exterior by a single median pore; no bursa into which ends of setae retract ---------- **Prometor Fisher, 1948**
      d[2]. No setae; anal vesicles more or less rudimentary, the branched tubules opening directly into thin-walled cloaca; dorsal blood vessel not directly connected with neurointestinal; body wall extremely thin; a specialized genital slit (see *Acanthohamingia*) extending forward from nephridiopores and forming a rudimentary androecium for parasitic males, which are provided with anterior curved setae; proboscis unknown ---------- **Amalosoma**[2] **Fisher, 1948**
    c[2]. One nephridium.
      d[1]. Setae 2, well developed; anal vesicles 2, elongate, dendritic; male unknown ---------- **Protobonellia Ikeda, 1908**
      d[2]. Setae 8–10 tiny integumentary spinelets, without muscle apparatus, situated in genital slit extending forward from nephridiopore; body wall thin; males without setae ---- **Acanthohamingia Ikeda, 1910**
      d[3]. Setae absent.
        e[1]. Skin thick, glandular; in place of proboscis a short truncate snout; voluminous branched anal vesicles present, the branchlets carrying

[2] Placed in this section because *Amalosoma* is close to *Acanthohamingia*, which has a *Thalassema*-like proboscis.

a multitude of vase-shaped excretory elements; siphon present; hind intestine abruptly enlarged_____ Nellobia Fisher, 1946

e[2]. Skin thin, translucent; *Thalassema*-like proboscis present; anal vesicles and siphon said to be lacking[3]____Sluiterina Monro, 1927

b[2]. Proboscis cleft at tip into 2 short or long lobes.

c[1]. Two nephridia; no setae_____ Hamingia Danielssen and Koren, 1880

c[2]. One nephridium.

d[1]. Setae 2, typical; dorsal and neurointestinal vessels very indirectly connected by capillaries_____ Bonellia Rolando, 1822

d[2]. Setae numerous (29) seated in 2 muscular pads from which muscles radiate; dorsal and neurointestinal blood vessels in direct connection[4]; male large (28.5 mm. long) without setae.

Acanthobonellia Fisher, 1948

b[3]. Proboscis a short truncate snout; see above_____ Nellobia Fisher, 1946

a[2]. Nephrostome at extreme distal end of nephridium; proboscis cleft at tip.

b[1]. Two nephridia serving as egg receptacles, between which is a small unpaired nephridium with a basal nephrostome.

Austrobonellia Fisher, 1948

b[2]. One nephridium, the distal end expanded into a large trumpet-shaped nephrostome.

c[1]. Two setae; neurointestinal vessel starting from intestine at a considerable distance beyond beginning of siphon; elements of anal vesicles short and stout_____ Bonelliopsis Fisher, 1946

c[2]. No setae; neurointestinal vessel spanning proximal end of siphon; elements of anal vesicles long and slender____ Eubonellia Fisher, 1946

a[3]. Nephrostome on a short stalk facing laterally near blind distal end of nephridium.

b[1]. The two nephridia with a small nephrostome laterally near distal end; a small blind tube, projecting into coelom and opening on ventral body wall between the 2 nephridiopores, containing a degenerate male, grown fast to walls of tubule by its posterior end (it lacks setae and has 2 sperm receptacles); gonad of female situated on frenula radiating from cloaca; anal vesicles in form of tubules opening independently into cloaca; 2 setae (plus 2 substitutes).

Pseudobonellia Johnston and Tiegs, 1919

b[2]. One nephridium; no setae; no androecium_____ Ikedella Monro, 1927

a[4]. Position of nephrostome unknown; a large median nephridium between 2 small ones; proboscis with 2 short terminal lappets; alimentary canal short, scarcely over twice length of body; size very small (12 mm.); 2 setae (plus 2 substitutes)_____ Archibonellia W. Fischer, 1919

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[3] Monro (1927, p. 618) bases the genus on the absence in the type, *Hamingia sibogae,* of siphon and anal vesicles. Sluiter (1902, p. 44, pl. 4, fig. 7) states that the siphon and anal vesicles "seem" to be absent, "was aber nicht ganz sicher ist, da der darm sehr gelitten hat und die Verhältnisse nicht sicher gestellt werden konnten." His figure shows only a small part of the anterior portion of alimentary canal and nothing of the posterior part of the internal anatomy. The text figure of entire animal indicates a proboscis much like that of *Maxmülleria,* but the tip looks as if it had been injured and was starting to regenerate. *Sluiterina sibogae* was dredged in 4,391 meters, on nearly black mud, in the Banda Sea.

[4] Although Ikeda (1907, p. 4) gives no figures of topographical anatomy, he says, "The posterior end of the esophagus is embraced by the heart, a broad vascular sinus of a triangular shape with the apex directed forward. From the basal angles of the heart, there arise two moderately long vessels (commissures) which eventually join the ventral vessel running over the nerve cord." This is the arrangement in *Thalassema* and *Echiurus,* and very different from that of *Bonellia.*

Genus PROMETOR Fisher

Prometor Fisher, 1948, p. 857 (type, *P. benthophila* Fisher).

Diagnosis.—Related to *Maxmülleria* Bock; proboscis long and ribbonlike, truncate, the borders fused at base to form a differentiated funnel or cup leading to mouth; one pair of anterior nephridia, into the specialized basal portion of which opens the large nephrostome, which is compressed, fan-shaped, and bilabiate; a single common external nephridiopore; two well-developed setae close together, without a common external bursa into which both can retract; anal vesicles unbranched sacs with a great number of glandular excretory tubules having an apical ciliated funnel; neurointestinal blood vessel directly connected with dorsal; longitudinal muscle layer continuous; only females known; probably sexual dimorphism with dwarf males.

Remarks.—This genus differs from *Maxmülleria* Bock (1942, p. 22) in the presence of a specialized funnel or cup at the base of proboscis, in having only a single nephridiopore, and in lacking a specialized external bursa into which the two closely placed setae can be retracted.

The blood system of *Maxmülleria* and *Prometor* is more like that of *Thalassema* than of the Bonelliidae (*Acanthobonellia* and *Haminga* excepted). The neurointestinal connects directly with the dorsal vessel, a small ring vessel being present. This, however, is on the intestine at the beginning of siphon, and not at end of foregut, as in *Echiurus* and *Thalassema*.

PROMETOR BENTHOPHILA Fisher

Plates 33, 34

Prometor benthophila Fisher, 1948, p. 857, figs. 1–5.

Description.—Body somewhat slender pear-shaped; anterior third of body wall opaque, tough, the skin with fine transverse wrinkles between very numerous low, flat, closely placed glandular elevations. These are of many sizes, the largest about 1 mm. in diameter, of irregular contour and the surface is smooth in contrast to the wrinkled skin between. Posterior two-thirds of body thinner, translucent, smooth, and without glands, even around anus. The innermost muscular layer is smooth. Length of paratype without proboscis, about 110 mm.

The proboscis is a fleshy ribbon about 55 mm. long (type), the base forming a cup into which the mouth opens, this cup comprising about 7 mm. of the total length. Its lining is folded as if considerable contraction had taken place. In the paratype (pl. 33, fig. 1) the proboscis appears to have been undergoing regeneration. The cup or funnel comprises nearly all the proboscis. The lumen of its constricted basal portion is small and the lining is furrowed longitudinally like a gullet.

In life it is likely that a normal proboscis can be extended at least a meter in length.

About 5 mm. posterior to constricted base of proboscis is the common aperture of the two nephridia, and just in front of these and close together are the broken tips of two slender setae (10 mm. long). Upper ends of setae close together and interbasal muscle short. The basilateral muscles are less numerous and stouter than in *Maxmülleria lankesteri* (Bock, 1942, pl. 4, fig. 1).

Nephridia two, large. The proximal part, into which the large fan-shaped nephrostome opens, is sharply differentiated from the much larger distal portion in which the eggs are stored and is marked by a few shallow furrows. In the type, the wall of the distal portion is opaque but in the paratype it is translucent, so that the few large contained eggs can be seen. The nephridia open by a single median nephridiopore close behind the setae.

The two anal vesicles are elongate sacs. One side of each is fixed to the wall of the mud-filled cloaca. The free surface of each vesicle is closely covered with fusiform, brown excretory tubules, about 0.5 mm. long, from which the terminal funnel has been lost by maceration.

Alimentary canal: The intestine consists of fragments ruptured from foregut. In the paratype the foregut is sufficiently intact to show its subdivisions. The buccal cavity or anterior part of pharynx is connected with body wall by numerous radiating muscular frenula. The rest of the pharynx is anchored only by the dorsal and ventral mesenteries not shown in figure. The esophagus (proventriculus of Bock) is externally marked by slight constrictions and the very short gizzard by more widely spaced ones. The stomach (*C*) ends apparently at a permanent sharp elbow where there is a sphincter. The presiphonal segment of intestine is short and devoid of a ciliated groove. The mucosa of pharynx, esophagus, and gizzard is thick, marked by longitudinal and circular furrows, but that of gizzard is not so thick as the mucosa of the distal part of esophagus, which is thrown into prominent lappets much as indicated by Bock (1942, pl. 9, fig. 10). The lining of stomach is thinner than that of gizzard and only the longitudinal furrows are present. The cloaca is thin-walled, crowded with mud, and closely attached dorsally by delicate frenula. There are no ventral frenula. In the paratype a short piece of intestine remains attached to the cloaca. There is no indication of a coecum.

The vascular system is of the echiurid and not bonelliid type. The neurointestinal vessel, however, arises directly by three roots from the dorsal. The ring vessel appears to be of secondary importance. A bonelliid feature is the position of this plexus at the beginning of the siphon and not at the end of the stomach.

The ovary lies along the top of the ventral blood vessel. Its anterior end is well forward but the posterior limit can not be determined.

Male.—Unknown. Search was made in the funnel at base of pharynx and in the pharynx.

Type.—U.S.N.M. No. 21076.

Type locally.—*Albatross* station 4387, off San Diego, Calif., lat. 32°32′ N., long. 118°04′20″ W., 1,059 fathoms, green mud; 2 incomplete specimens.

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EXPLANATION OF PLATES

[All figures were made by the writer directly from dissections or specimens.]

PLATE 28

Anelassorhynchus abyssalis, new species

1. Anterior complex of type, × 10. The foregut has been drawn to right to reveal the setae and nephridia. (B^1, B^3, B^4, dorsal, neurointestinal, and ventral blood vessels, respectively; *C*, stomach; *CF*, ciliated funnel of nephrostome; *G*, gizzard; *I*, small segment of intestine; *MI*, interbasal muscle; *N*, nephridium; *NC*, nerve cord; *O*, esophagus; *P*, pharynx; *S*, seta; *SM*, seta muscle described in text; *VM*, double ventral mesentery.)
2. Seta of type, × 10.

PLATE 29

Listriolobus hexamyotus, new species

1. Seta from paratype, × 10.
2. Anterior complex of type, × 10. The foregut is drawn to right to show the nephridia and foreshortened setae. On left, a seta, *S′*, is drawn full length. From where seta sheath meets body wall, a muscle, *SM*, extends laterally, one edge attached to body wall and the other free, the outer end near dorsolateral longitudinal muscle band, *ML′*. (B^1–B^3, dorsal, ring, and neurointestinal blood vessels, respectively; *C*, stomach; *CF*, ciliated funnel of nephrostome; *G*, gizzard; *I*, presiphonal intestine, its ciliated groove dotted; *MI*, interbasal muscle; *ML*, position of right ventrolateral muscle of body wall; *ML′*, left dorsolateral muscle; *N*, nephridium; *NC*, nerve cord; *P*, pharynx; *S*, seta; *S′*, a seta pressed flat to show length; Si^1, proximal end of siphon; *SM*, dotted, lateral seta muscle described in text; *VM*, ventral mesentery of pharynx-esophagus.)
3. Side view of paratype, × 2.
4. Skin papillae from near setae, much enlarged.

PLATE 30

Arhynchite californicus, new species

1. Dissection of anterior complex of type, × 7. The anterior part of foregut is in situ, the distal part drawn to right to show nephridia. The + beneath

interbasal muscle indicates position of the extra nephridium. The neuro-intestinal vessel, B^3, emerges from between the two ventral mesenteries to encircle the interbasal muscle. (Lettering as for plates 28 and 29.)

2. A proboscis, ventral side, × 2.
3. Tip of proboscis, × 5.
4. Portion of proboscis near base, × 5.
5. Ventral side of anterior end of type, × 4.

PLATE 31

Arhynchite pugettensis, new species

1. Map of alimentary canal, × 2, in approximate natural position when animal is opened along middorsal line. The foregut is unshaded; presiphonal gut in solid black; siphonal gut unshaded; postsiphonal gut stippled. Muscular mesenteries and details of anterior complex omitted. Only left nephridium shown in entirety. (*AV*, anal vesicles; *CF*, nephrostome; *Cl*, cloaca; *I*, presiphonal intestine; *N*, nephridium; Si^1 and Si^2, beginning and end of siphon.)
2. The segment of presiphonal gut between ++ of fig. 1 to show arrangement of muscular mesenteries attached near nerve cord. (*NC*, nerve cord.)

PLATE 32

Arhynchite pugettensis, new species

1. Anterior complex, × 5. The foregut has been drawn far to right and only the beginning of presiphonal gut is shown. (*M*, muscular mesenteries of foregut; *M'*, mesentery of presiphonal gut; *CG*, ciliated groove of presiphonal gut; other letters as for plates 28 and 29.)
2. Proximal end of detached, incomplete proboscis, × 2: *a*, Dorsal, and *b*, ventral aspects; *c*, the basal aperture enlarged.

PLATE 33

Prometor benthophila Fisher

1. Ventral view of paratype, natural size. The thin-walled posterior portion of body was badly torn so that reconstruction was necessary. The inflation is probably artificial. Proboscis was evidently undergoing regeneration.

1a. Ventrolateral aspect of anterior end of paratype, × 2.

2. Ventral view of anterior end of type, natural size, to show the basal funnel of proboscis (leading to mouth), the two setae, and single nephridiopore.

2a. Lateral view of proboscis funnel, enlarged.

2b. Setae (*S*), nephridiopore (*NP*), and surrounding skin of type, × 10. The tip of each seta is missing.

2c. Basal portion of nephridia, showing the compressed fan-shaped nephrostomes or ciliated funnels (*CF*), × 5. A portion of nerve cord (*NC*) has been removed; *N*, thinner-walled portion of nephridium.

PLATE 34

Prometor benthophila Fisher

1. Anterior portion of alimentary canal of paratype arranged to show the different parts of the foregut and circulatory system, × 4 In the natural

position the portion of the dorsal blood vessel, B^1, attached to esophagus is nearly middorsal. The nerve cord is shown without the close serpentine twisting due to contraction of body wall. (*Go*, ovary.)

2. Nephridia of type, the proximal portion, due to contraction of body wall, overlapped by the seta apparatus, × 4.

2a. Ventral aspect of cloacal complex of type, × 3. The cloaca has been turned backward owing to the attachment of dorsal wall of cloaca to body wall. The anterior end of cloaca is below; the circle indicates passage into intestine which was torn off. *AV* is the anterior lobe of anal vesicle and the numerous villiform nephric tubules normally hang from the underside of the vesicle. Position of anus at *A*.

(Lettering as for plates 28 and 29.)

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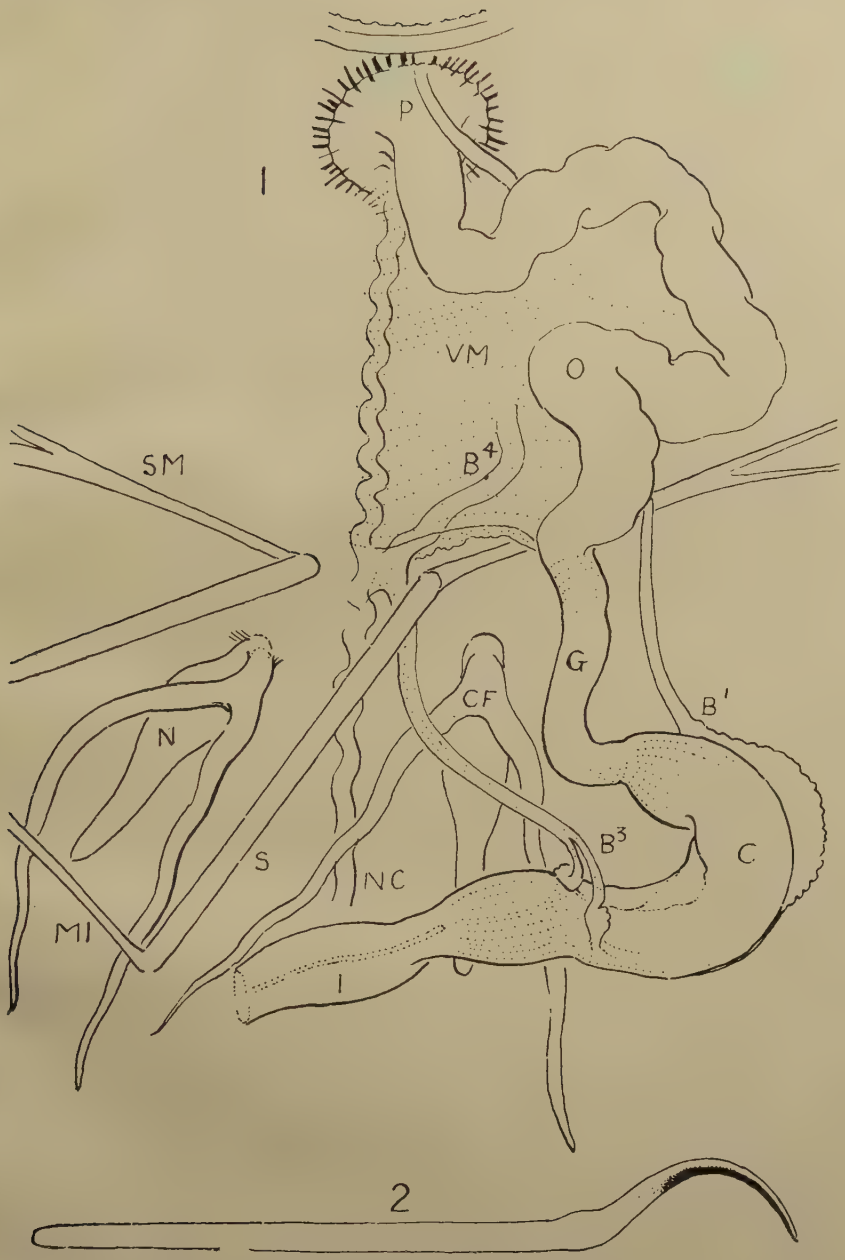
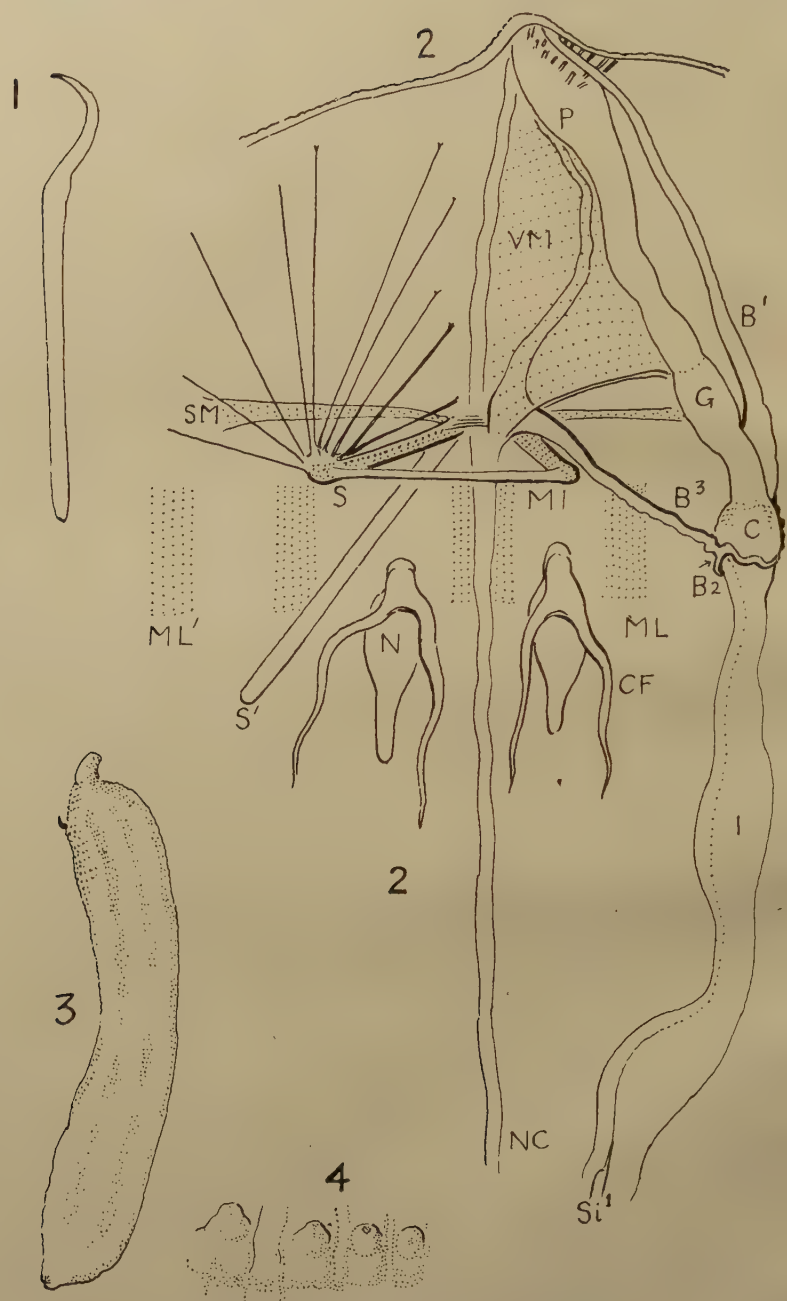


ANELASSORHYNCHUS ABYSSALIS, NEW SPECIES.

FOR EXPLANATION SEE PAGE 495.



LISTRIOLOBUS HEXAMYOTUS, NEW SPECIES.

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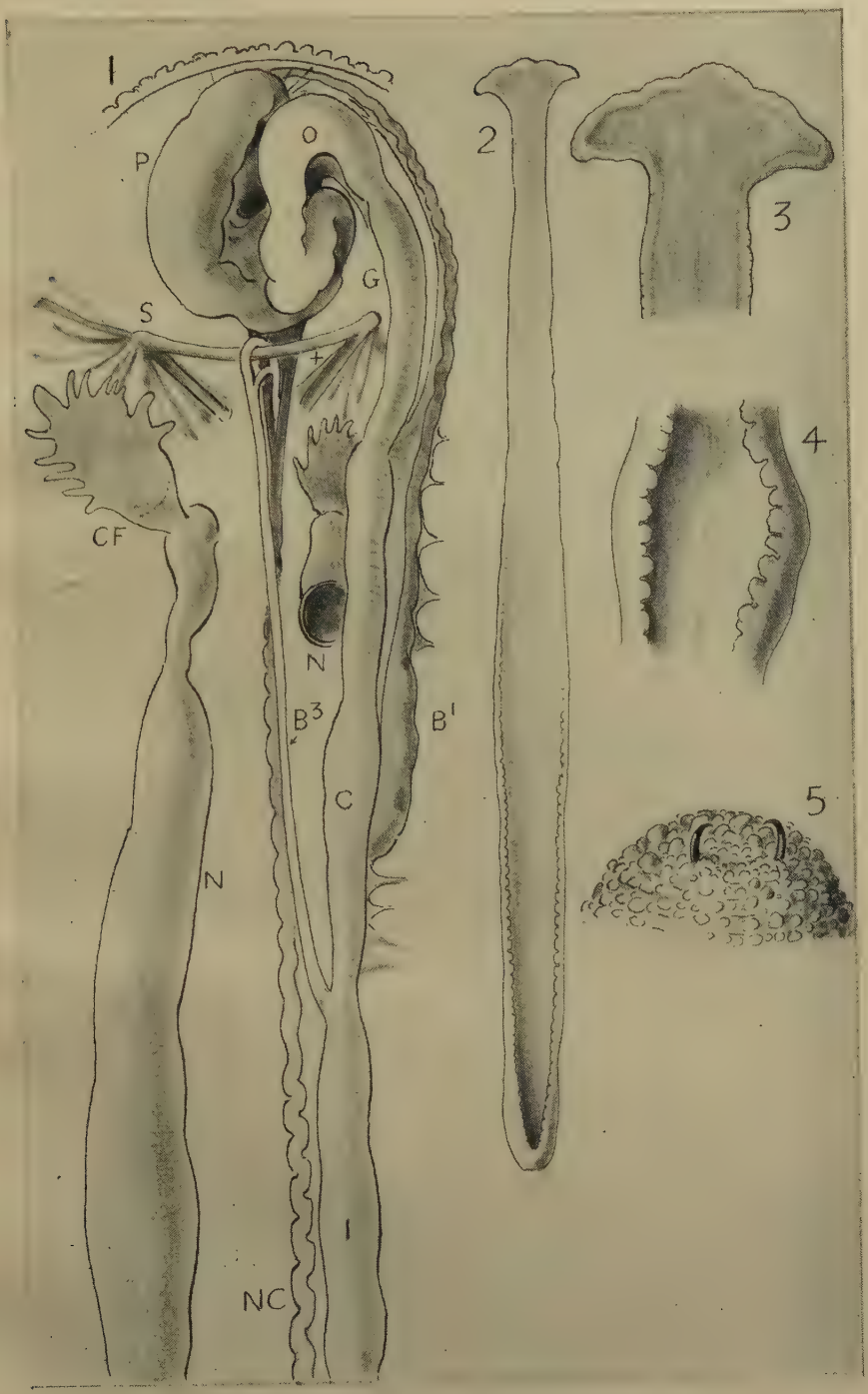
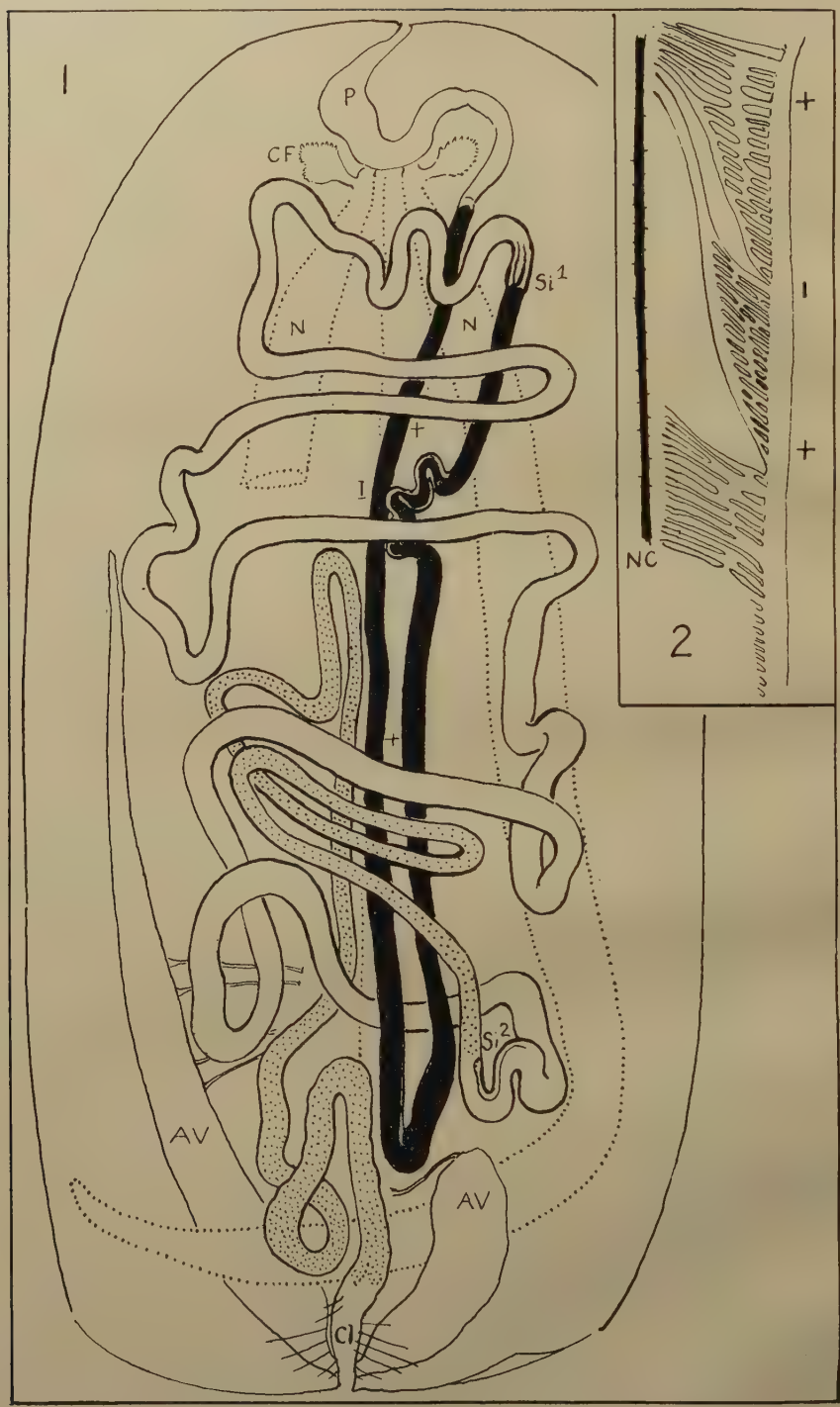


ARHYNCHITE CALIFORNICUS, NEW SPECIES

FOR EXPLANATION SEE PAGES 495–496.



ARHYNCHITE PUGETTENSIS, NEW SPECIES.

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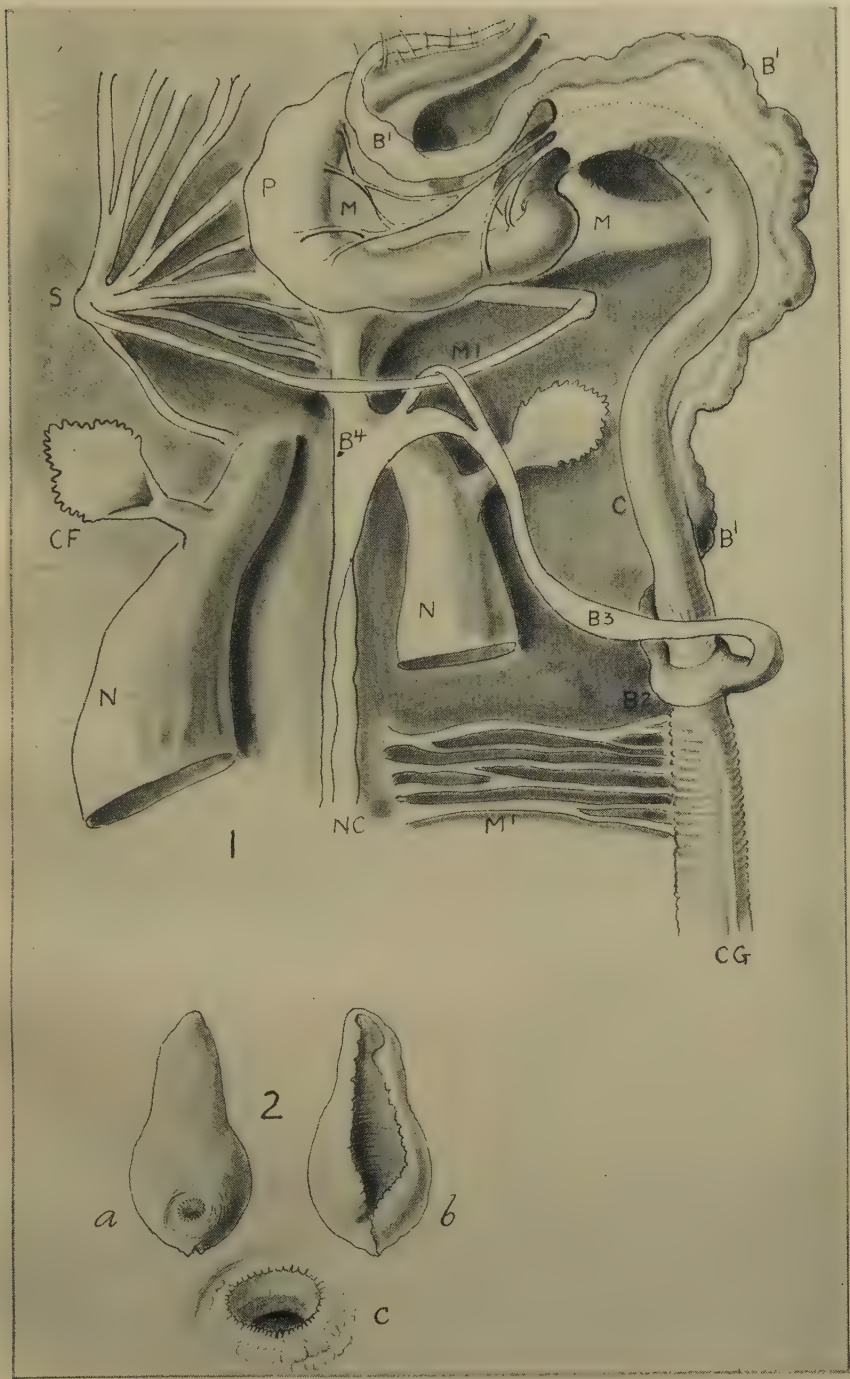

ARHYNCHITE PUGETTENSIS, NEW SPECIES.

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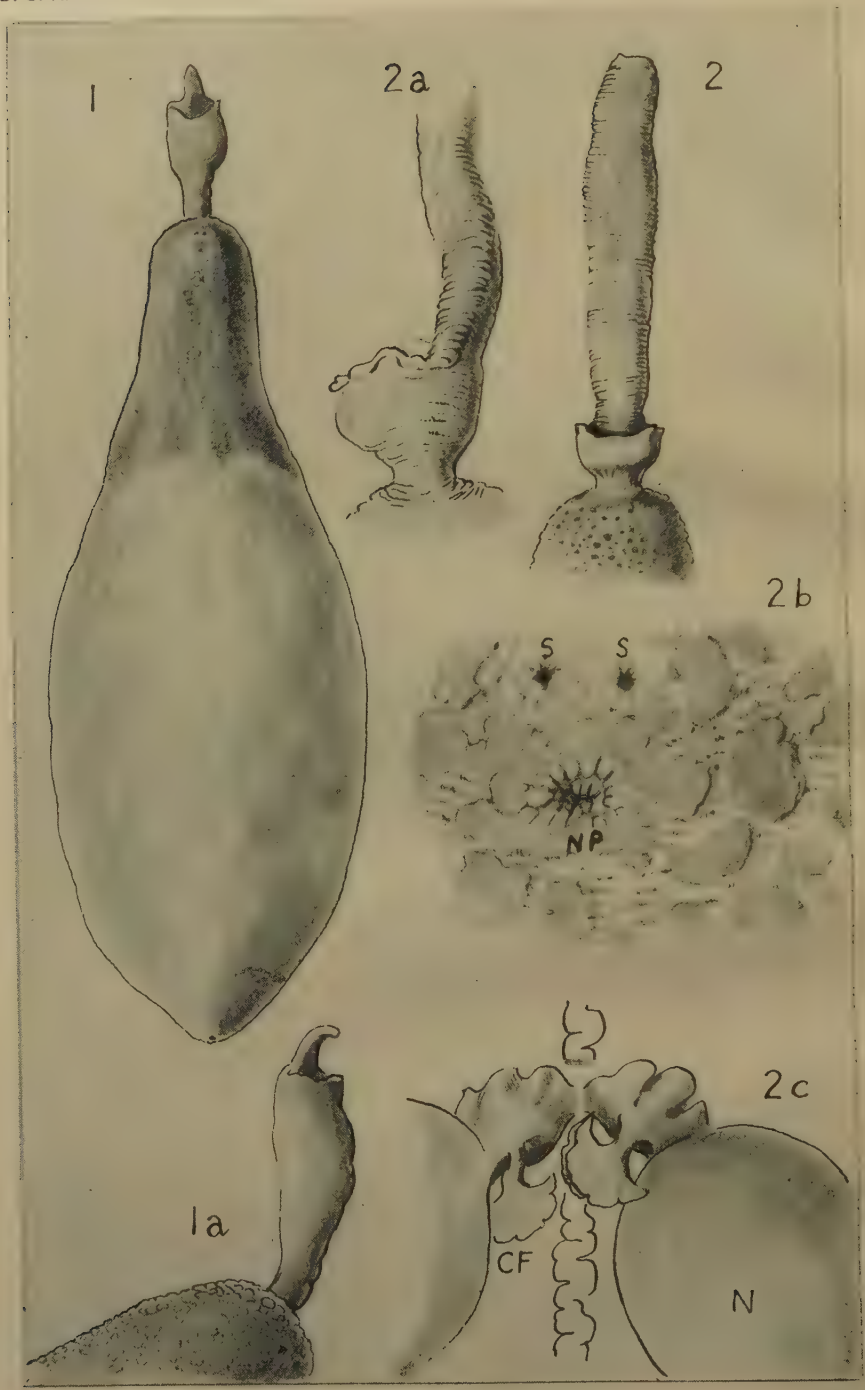

PROMETOR BENTHOPHILA FISHER.

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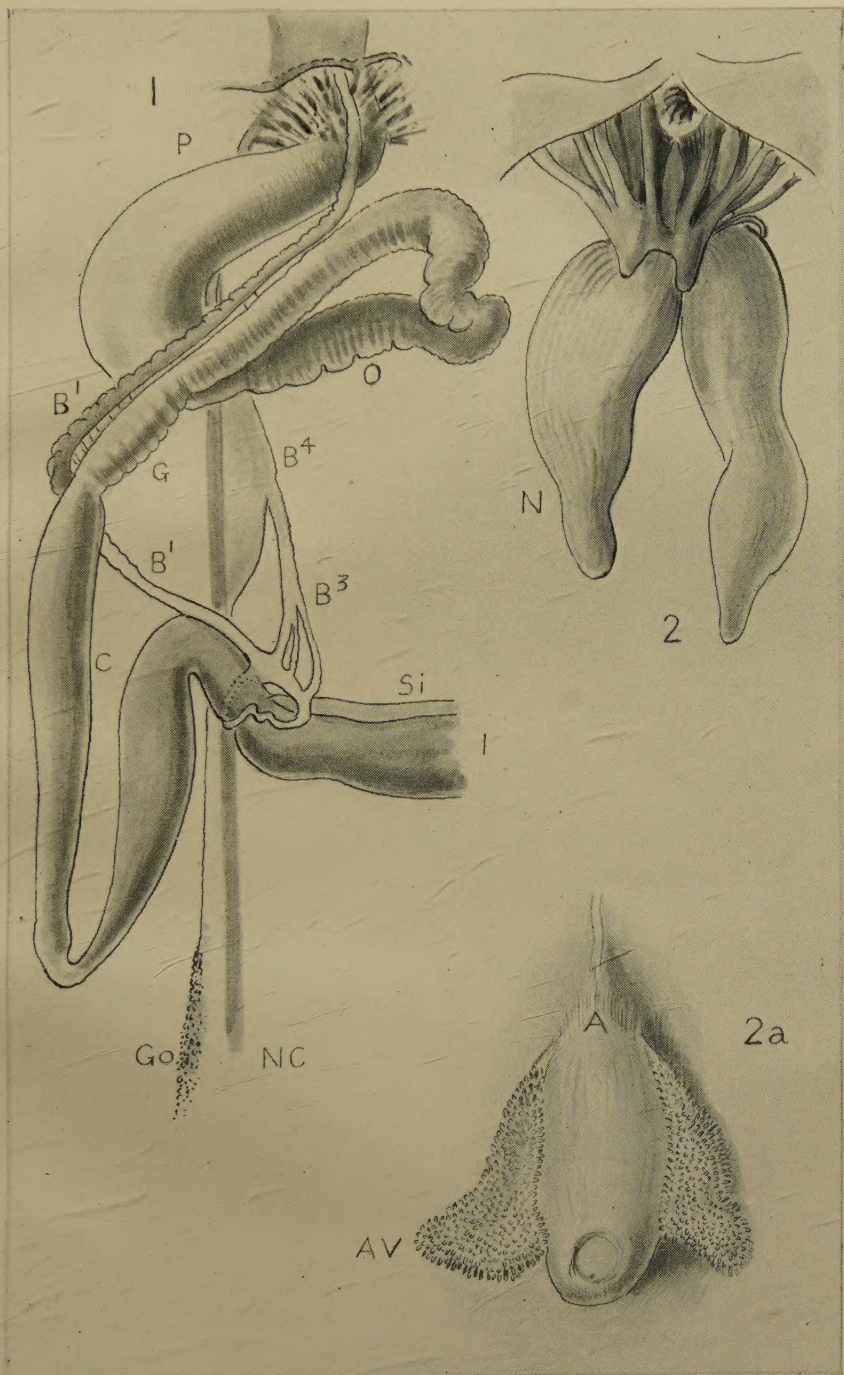

PROMETOR BENTHOPHILA FISHER.

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